L Series
Laboratory
DC Power Supply

Instruction Manual

Sorensen

The power you need

Sorensen

L Series
Laboratory
DC Power Supply

Instruction Manual

LT Models:

LT 18-5
LT 30-3

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- Equipment purchased in the United States carries only a United States warranty for which repair must be accomplished at the Sorensen factory.

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SAFETY NOTICE

CAUTION

Before applying power to the unit, verify that the AC input selector switch is set to the voltage of the AC power source; exceeding the maximum rated AC input voltage could result in damage to the unit. To avoid a fire hazard, ensure that the AC input fuse has the proper rating for the AC power source voltage.

Before connecting the unit to the AC power source, ensure that the front panel POWER switch is in the OFF position.

WARNING

There are no operator serviceable components or adjustments within the unit. Hazardous voltages of up to 264VRMS, 373VPK may be present within the unit when the covers are removed. Only qualified service personnel should service this equipment.

Use caution when working inside the unit: Guard against risks of electrical shock during open cover checks by not touching any components, circuit boards, or test points with power applied to the unit. Even with power off, capacitors may retain an electrical charge that could be hazardous. Use safety glasses during open cover checks to avoid personal injury in case of sudden component failure.

WARNING

To prevent electrical shock, the enclosure of this unit must be connected to a safety earth ground. This is accomplished through the ground wire of the power cord. The ground terminal of the power cord must be connected to the safety ground of the AC power source. Do no remove the ground terminal of the power cord, and do not operate this unit with the enclosure ungrounded and floating.

High energy levels can be stored at the output terminals of the power supply during normal operation; use caution to prevent shorting the output terminals. Voltages of greater than 60VDC are considered dangerous; ensure that wiring and terminations going to the load are suitably insulated. Do not operate the power supply in an environment with a flammable atmosphere.

In servicing the power supply, substitution of parts or unauthorized modifications could compromise the safe operation of the unit and result in a hazardous condition.

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SECTION 1
GENERAL DESCRIPTION

1.1 INTRODUCTION

The LT Models comprise a family of Laboratory Power Supplies designed for benchtop and portable applications. The family consists of two models providing triple outputs: dual adjustable outputs of 18V at 5A or 30V at 3A, and a fixed 5V output at 3A. These supplies are manually adjusted, and may be operated as variable voltage sources or current sources.

1.2 GENERAL DESCRIPTION

The power supplies utilize linear series-pass output stages to provide enhanced performance characteristics such as excellent regulation (0.01%), low noise (1mV), and fast transient response (100μs). They could be operated as precisely regulated voltage sources in constant-voltage (CV) mode or current sources in constant-current (CC) mode. Crossover between modes is automatic, being dependent on load demand.

Front panel controls are provided to adjust the voltage and current from 0 to 100% of rating. Front panel switches allow configuring the adjustable outputs for independent, series-tracking, or parallel-tracking operation. The 3-1/2 digit LED displays are provided for both adjustable outputs; they are switch-selectable for displaying either voltage or current. Also, front panel CV and CC indicators allow determination of whether the power supply is operating in constant-voltage or constant-current mode. The 5V output has an indicator for annunciation of an overload condition.

The outputs are isolated from the chassis. This allows operation with floating outputs, or with either the positive or negative lead of an output referenced to chassis ground. If an output voltage is required greater than available in a single unit, multiple units could be connected in series to provide a maximum output voltage of 300V. The output is fully protected for overload, short-circuit, and reverse polarity. Binding posts are conveniently located on the front panel to provide connection for all three of the power supply outputs as well as the chassis ground.

1.3 SPECIFICATIONS

1.3.1 Constant Voltage Operation

1.3.1.1 Output Voltage Adjustment Range

LT 18-5

0 to 18VDC — Independent and Parallel-Tracking Operation
0 to 36VDC — Series-Tracking Operation with Single Output
0 to ±18VDC — Series-Tracking Operation with Dual-Polarity Outputs

LT 30-3

0 to 30VDC — Independent and Parallel-Tracking Operation
0 to 60VDC — Series-Tracking Operation with Single Output
0 to ±30VDC — Series-Tracking Operation with Dual-Polarity Outputs

1.3.1.2 Output Voltage Line Regulation

≤0.01% + 3mV — Independent and Parallel-Tracking; Series-Tracking with Dual-Polarity Outputs

≤0.01% + 5mV — Series-Tracking with Single Output

1.3.1.3 Output Voltage Slave Tracking Error

≤0.5% + 10mV at no load, add ≤300mV at full load — Dual-Polarity Outputs

1.3.1.4 Output Voltage Load Regulation

≤0.02% + 5mV for LT 18-5, ≤0.01% + 3mV for LT 30-3 — Independent and Parallel-Tracking; Series-Tracking with Dual-Polarity Outputs

≤300mV — Series-Tracking with Single Output

1.3.1.5 Output Voltage Temperature Coefficient

≤300PPM/°C

1.3.1.6 Output Voltage Recovery Time

≤100μs for 50% load change, 0.5A minimum load

1.3.1.7 Output Voltage Ripple and Noise

≤1mV(RMS), measured with a bandwidth of 5Hz to 1MHz

1.3.2 Constant Current Operation

1.3.2.1 Output Current Adjustment Range

LT 18-5

0 to 5ADC — Independent and Series-Tracking Operation
0 to 10ADC — Parallel-Tracking Operation

LT 30-3

0 to 3ADC — Independent and Series-Tracking Operation
O to 6ADC — Parallel-Tracking Operation

1.3.2.2 Output Current Line Regulation

≤0.2% + 3mA

1.3.2.3 Output Current Load Regulation

≤0.2% + 3mA

1.3.2.4 Output Ripple Current

≤3mA(RMS)

1.3.3 5V Fixed Output

1.3.3.1 Output Voltage Accuracy

5V ±0.25V

1.3.3.2 Output Voltage Line Regulation

≤5mV

1.3.3.3 Output Voltage Load Regulation

≤10mV

1.3.3.4 Output Voltage Ripple and Noise

≤2mV(RMS)

1.3.3.5 Output Current

3A, minimum

1.3.4 AC Input Characteristics

1.3.4.1 AC Input Voltage Range

100V/120V/220V/240V ±10%, switch selectable

1.3.4.2 AC Input Frequency

50Hz or 60Hz

1.3.4.3 AC Input Fuse

LT 18-5

T8A/250VAC, time-delay, for 100/120VAC operation
T4A/250VAC, time-delay, for 220/240VAC operation

LT 30-3

T6.3A/250VAC, time-delay, for 100/120VAC operation
T3.15A/250VAC, time-delay, for 220/240VAC operation

1.3.5 Mechanical Specifications

1.3.5.1 Dimensions

255mm(W) × 145mm(H) × 335mm(D) (10"W × 5.7"H × 10.2"D)

1.3.5.2 Weight

11.5Kg (23.5lb)

1.3.6 Environmental

1.3.6.1 Operating Temperature Range

0°C to 40°C

1.3.6.2 Storage Temperature Range

-10°C to 70°C

1.3.6.3 Humidity

<80%, operating; <70%, storage

1.3.7 General Characteristics

1.3.7.1 Display Type

Digital, 3.5 digits, 0.5" red LED

1.3.7.2 Display Accuracy

±(0.5% of reading + 2 digits)

1.3.7.3 Display Voltage Range

19.99V for full scale in LT 18-5
199.9V for full scale in LT 30-3

1.3.7.4 Display Current Range

19.99A for full scale

SECTION 2
INSTALLATION

2.1 INTRODUCTION

The LT Model Laboratory Power Supply has been fully calibrated and tested prior to shipment. Therefore, the unit is ready for immediate use upon receipt. However, when first unpacked, the unit should be inspected to ensure that no shipping damage had occurred.

2.2 INITIAL INSPECTION

Perform a visual inspection of the shipping container prior to accepting the package from the carrier. If extensive damage to the shipping container is evident, a description of the damage should be noted on the carrier's receipt and signed by the driver of the carrier's agent.

If damage is not apparent until the unit is unpacked, a claim for concealed damage should be placed with the carrier. In addition, the shipping container and filler material should be saved for inspection. Forward a report of the damage to the Sorensen Service Department. Sorensen will provide instructions for repair or replacement of the unit.

2.3 PHYSICAL INSPECTION

Perform a visual inspection of the unit after it is removed from the shipping container. Check for shipping damage such as dents, scratches, distortion of the enclosure, or damaged controls. If external damage is evident, remove the cover and also check for internal damage to circuit boards or components.

2.4 LOCATION OF APPLICATION

The unit is designed for benchtop and portable applications. Since it is fan-cooled, it requires adequate clearance at the air intake and exhaust so that air flow is not impeded. The air intake is at the rear of the unit, and the air exhaust is from the perforations in the cover. The temperature of the ambient air should not exceed 40°C.

2.5 INPUT POWER REQUIREMENTS

The unit will operate from an AC power source rated at 100/120/220/240VAC, ±10% at 50/60Hz. Before connecting to the AC power source, ensure that the AC LINE SELECT switches on the rear panel are set for the available voltage, and that the fuse rating is appropriate for the voltage selected. Refer to Figure 2-1 for the location of the AC LINE SELECT switches and the AC line fuse.

CAUTION

Exceeding the maximum rated AC input voltage could result in damage to the unit. Operating with a fuse of improper rating could result in a fire hazard.

An IEC connector is provided on the rear panel for connecting the unit to the AC power source with a power cord; the IEC connector also provides the safety ground termination. The power cord supplied with the unit has a safety ground wire that connects the enclosure of the unit to the safety ground of the AC power source. This connection is automatically made when the power cord is plugged into an appropriate AC receptacle.

WARNING

Operating the unit with the safety ground wire of the power cord disconnected could result in a shock hazard.

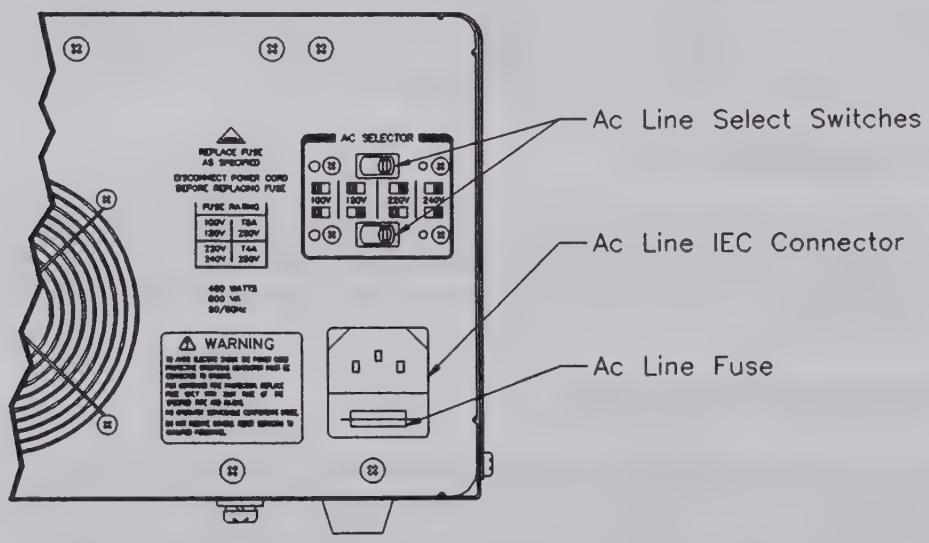

Figure 2-1. Rear Panel AC Switches, Fuse, and Connector

2.6 AC LINE VOLTAGE SELECTION

Determine the nominal voltage rating of the AC power source: either 100VAC, 120VAC, 220VAC, or 240VAC. Refer to Figure 2-1 for the positions of the AC LINE SELECT switches required to select one of the four nominal values.

CAUTION

To prevent damage to the unit, disconnect the AC power cord before changing the settings of the AC LINE SELECT switches on the rear panel.

2.7 AC LINE FUSE

Check that the fuse installed in the fuse holder has the proper rating for the AC power source voltage. To extract the fuse, snap out the plastic panel that holds the fuse in the fuse holder. The fuse ratings are listed in Subsection 1.3.4.3, AC INPUT FUSE, and also in a table on the rear panel of the unit. Refer to Figure 2-1 for the location of the table.

WARNING

To prevent electrical shock, disconnect the AC power cord before checking the fuse.

2.8 LOAD CONNECTIONS

2.8.1 Load Wiring

When connecting the load to the power supply, the following factors must be considered when selecting a suitable wire gauge:

1. The current carrying capacity of the wire (limited by temperature rise of the wire)

2. The voltage drop across the total length of load lines

3. Noise coupling and impedance effects of the load lines

2.8.2 Wire Current Carrying Capacity

Load wiring must have a current carrying capacity greater than the output current rating of the power supply. This ensures that the wiring will not be damaged even if the load is shorted. Table 2-1 shows the maximum current rating, based on 450A/cm^2, for various gauges of wire rated for 105°C operation. Operation at the maximum current rating results in approximately a 30°C temperature rise for a wire operating in free air. When load wiring must operate in

areas with elevated ambient temperature or bundled with other wiring, larger gauges or higher temperature-rated wiring should be used.

AWG	Copper Area cm^2	Resistance Ω/m, at 20°C	Resistance Ω/m, at 100°C	Current Rating A, at 450A/cm^2
6	0.13301	0.0013	0.0017	59.9
8	0.08368	0.0021	0.0028	37.7
10	0.05262	0.0033	0.0044	23.7
12	0.03309	0.0052	0.0069	14.9
14	0.02081	0.0083	0.0110	9.4
16	0.01309	0.0132	0.0174	5.9
18	0.00823	0.0209	0.0276	3.7
20	0.00518	0.0333	0.0440	2.3
22	0.00326	0.0530	0.0700	1.5

Table 2-1. Wire Data

2.8.3 Wire Voltage Drop

For applications where regulation is important, the contribution of the load wiring to voltage drop from the power supply output terminals to the load must be considered. The wire gauge must be selected to maintain an acceptable total voltage drop of the load wiring under the maximum peak current. The resistance of the load wiring must be determined for the sum total length of the positive lead and the negative lead. Table 2-1 gives the resistance per meter (m) of various wire gauges at 20°C and 100°C. The following equation could be used to calculate the resistance for other wire temperatures:

$$R = R_{20°C} \times [1 + 0.004 \times (T\text{-}20°C)]$$

where

R = resistance, Ω/m, at temperature T
$R_{20°C}$ = resistance, Ω/m, at 20°C
T = temperature, °C, of wire

The voltage drop (per positive or negative lead) could be calculated using the following equation:

$$V = I \times L \times R_{20°C} \times [1 + 0.004 \times (T\text{-}20°C)]$$

where

V = total voltage drop, V
I = load current, A
L = length, m, of load wire
$R_{20°C}$ = resistance, Ω/m, of wire at 20°C
T = temperature, °C, of wire conducting load current

The total voltage drop would be calculated by summing the voltage drops of the positive and negative leads.

2.8.4 Noise and Impedance Effects

To minimize noise pickup or radiation from load circuits, load wires should be shielded twisted-pair with minimum lead length. Connect the shield only to the chassis of the power supply using the GND terminals. Even when shielding is impractical, the load wires should be twisted together to reduce noise coupling. When regulation is important, the wire gauge should be the largest practical and the wires should be twisted together to reduce their impedance.

2.9 LOAD CONNECTION CONFIGURATIONS

All three of the power supply outputs are isolated with respect to chassis ground. Either the positive or negative terminals could be connected to the chassis ground. The maximum voltage difference allowed between any of the three outputs is 100VPK. Also, either the positive or negative leads could be floated up to 300VPK with respect to chassis ground.

CAUTION

Operating the power supply with either the positive or negative output lead floated greater than 300VPK above chassis ground or with greater than 100VPK between any of the three outputs could result in damage to the unit.

2.9.1 Connecting Single Loads

Single loads should be connected with the largest gauge and the shortest length wire that is possible. The output voltage will be precisely regulated at the output terminals on the front panel of the unit.

2.9.2 Connecting Multiple Loads

When output voltage regulation is critical and multiple loads are connected to the power supply, it is important to connect each load independently to the power supply terminals on the front panel of the unit. Independent leads to each load will ensure that the load currents do not produce voltage drops in the connecting leads that could be mutually coupled between the loads.

The connecting wires should be of the largest gauge and shortest length possible. Refer to Figure 2-2.

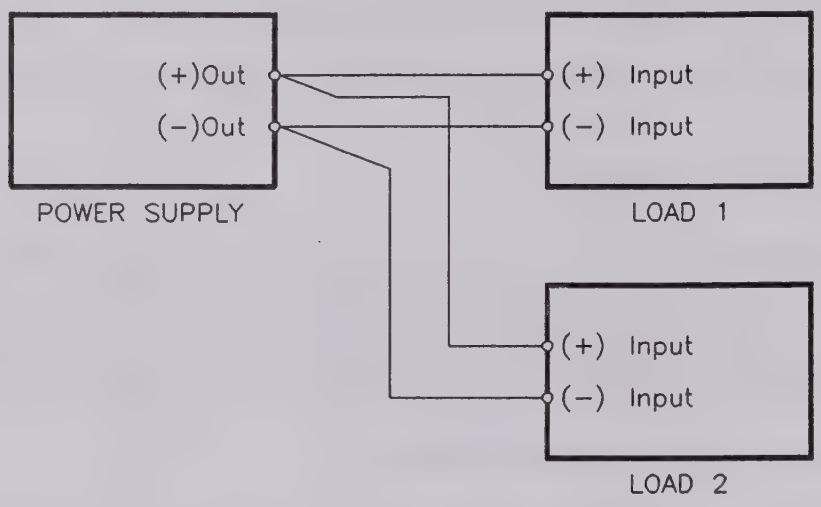

Figure 2-2. Multiple Load Connection

SECTION 3
OPERATION

3.1 INTRODUCTION

The LT Model Laboratory Power Supply has a full complement of controls, indicators, and connectors that allow the user to easily install, setup, and operate the unit.

3.2 CONTROLS, INDICATORS, AND CONNECTORS

Refer to Figure 3-1 for an illustration of the front panel and Figure 3-2 for an illustration of the rear panel.

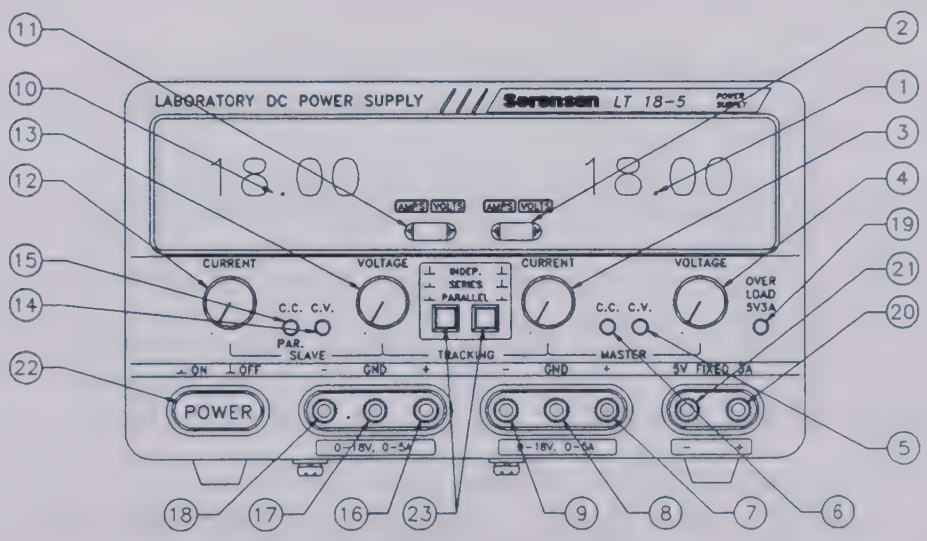

Figure 3-1. Front Panel Controls and Indicators

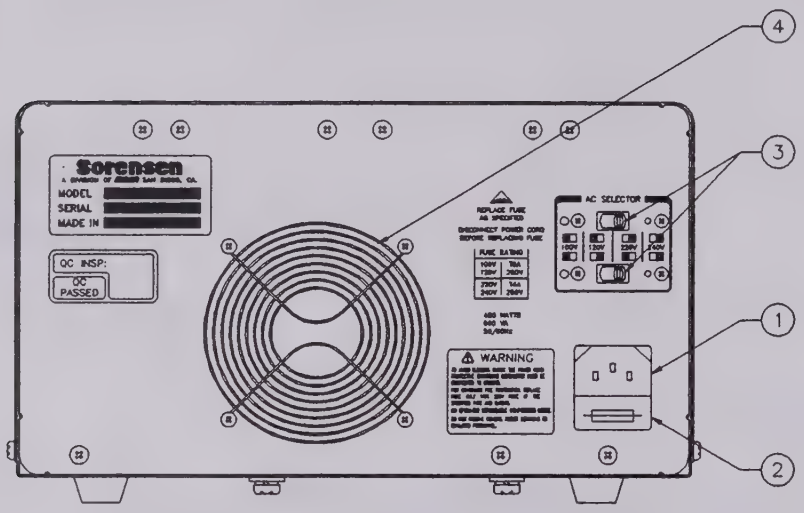

Figure 3-2. Rear Panel Controls and Connectors

3.3 FRONT PANEL

Refer to Figure 3-1 for the location of controls and indicators.

1. MASTER VOLTAGE/CURRENT DISPLAY: Indicates the value of the output voltage or the output current of the master section, as selected with the MASTER DISPLAY SELECTOR SWITCH.

2. MASTER DISPLAY SELECTOR SWITCH: Selects whether the output voltage (VOLTS) or the output current (AMPS) is displayed on the MASTER VOLTAGE/CURRENT DISPLAY; LED indicators identify which is selected.

3. MASTER CURRENT CONTROL: Provides adjustment of the output current for the master section. When in parallel-tracking mode of operation, also adjusts the output current of the slave section.

4. MASTER VOLTAGE CONTROL: Provides adjustment of the output voltage for the master section. When in series-tracking or parallel-tracking modes of operation, also adjusts the output voltage of the slave section.

5. MASTER CV INDICATOR: Indicates that the master output is in constant-voltage mode. The output voltage is being regulated, and the output current could vary. When in series-tracking or parallel-tracking modes of operation,

indicates that both the master and slave sections are in constant-voltage mode.

6. MASTER CC INDICATOR: Indicates that the master output is in constant-current mode. The output current is being regulated, and the output voltage could vary.

7. MASTER POSITIVE OUTPUT TERMINAL: Connects to the positive output of the master section. Colored red and labeled "+".

8. MASTER CHASSIS GROUND TERMINAL: Connects to the chassis ground for the master section. Colored green and labeled "GND".

9. MASTER NEGATIVE OUTPUT TERMINAL: Connects to the negative output of the master section. Colored black and labeled "-".

10. SLAVE VOLTAGE/CURRENT DISPLAY: Indicates the value of the output voltage or the output current of the slave section, as selected with the SLAVE DISPLAY SELECTOR SWITCH.

11. SLAVE DISPLAY SELECTOR SWITCH: Selects whether the output voltage (VOLTS) or the output current (AMPS) is displayed on the SLAVE VOLTAGE/CURRENT DISPLAY; LED indicators identify which is selected.

12. SLAVE CURRENT CONTROL: Provides adjustment of the output current for the slave section.

13. SLAVE VOLTAGE CONTROL: Provides adjustment of the output voltage for the slave section when in the independent mode of operation.

14. SLAVE CV INDICATOR: Indicates that the slave output is in constant-voltage mode. The output voltage is being regulated, and the output current could vary.

15. SLAVE CC/PAR INDICATOR: Indicates that the slave output is in constant-current mode (CC). The output current is being regulated, and the output voltage could vary. Also, indicates the parallel-tracking mode of operation (PAR).

16. SLAVE POSITIVE OUTPUT TERMINAL: Connects to the positive output of the slave section. Colored red and labeled "+".

17. SLAVE CHASSIS GROUND TERMINAL: Connects to the chassis ground for the slave section. Colored green and labeled "GND".

18. SLAVE NEGATIVE OUTPUT TERMINAL: Connects to the negative output of the slave section. Colored black and labeled "-".

19. OVERLOAD INDICATOR: Indicates that the current limit (3A) of the fixed 5V output has been exceeded.

20. 5V POSITIVE OUTPUT TERMINAL: Connects to the positive output of the fixed 5V section. Colored red and labeled "+".

21. 5V NEGATIVE OUTPUT TERMINAL: Connects to the negative output of the fixed 5V section. Colored black and labeled "-".

22. POWER SWITCH: Turns the unit ON and OFF.

23. TRACKING SWITCHES: Two switches that select the mode of operation of the master and slave sections. When both switches are disengaged (out), the independent mode of operation is selected. When both switches are engaged (in), the parallel-tracking mode operation is selected. When the left switch is engaged (in) and the right switch is disengaged (out), the series-tracking mode of operation is selected.

3.4 REAR PANEL

Refer to Figure 3-2 for the location of controls and connectors.

1. AC LINE INPUT: IEC connector for the AC input power cord.

2. AC LINE FUSE HOLDER: Contains the AC input fuse. The fuse is located on a plastic panel that snaps into the body of the fuse holder.

3. AC LINE SELECT SWITCHES: Two switches that convert the operation of the unit for 100/120/220/240VAC AC power sources.

4. AIR INTAKE: Air intake for cooling fan.

3.5 INITIAL FUNCTIONAL TESTS

3.5.1 Power-On Check

1. Ensure that the POWER switch is in the OFF position (switch button out).

2. Ensure the TRACKING switches are both disengaged (out).

3. Turn all of the controls for the VOLTAGE and CURRENT fully counter-clockwise.

4. Connect the power cord to an AC power source that matches the voltage setting

of the rear panel AC LINE SELECT switches.

5. Turn the front panel POWER switch to the ON position (switch button in).

6. Ensure that both of the front panel digital displays are on and that both of the displays indicate zero. Also, the CC indicators should be illuminated and the CV and OVERLOAD indicators should be off.

7. Turn both of the controls for the CURRENT 1/2 turn clockwise.

8. Ensure that the CV indicators are illuminated and that the CC and OVERLOAD indicators are off.

3.5.2 Constant-Voltage Mode Operation Check

1. Ensure that the front panel POWER switch is in the OFF position (switch button out).

2. Ensure the TRACKING switches are disengaged (out).

3. Turn all of the VOLTAGE and CURRENT controls on the front panel fully counter-clockwise.

4. Have a digital voltmeter (DVM) available to measure each of the output terminals on the front panel, observing the correct polarity. The DVM must have better than 0.1% accuracy.

5. Turn both of the controls for the CURRENT 1/2 turn clockwise.

6. Turn the front panel POWER switch to the ON position (switch button in).

7. Slowly turn each of the controls for the VOLTAGE clockwise and observe the values of the VOLTAGE display and the DVM. Adjust the controls for the VOLTAGE across their full ranges.

8. Compare the DVM reading with each of the front panel display readings to verify the accuracy of the front panel displays for VOLTAGE.

9. Ensure that the controls for VOLTAGE adjust the output voltage across the full rated voltage range. Also, the CV indicators should be illuminated and the CC and OVERLOAD indicators should be off.

3.5.3 Constant-Current Mode Operation Check

1. Ensure that the front panel POWER switch is in the OFF position (switch button out).

2. Ensure that the TRACKING switches are both disengaged (out).

3. Turn the VOLTAGE and CURRENT controls on the front panel fully counter-clockwise.

4. Turn both of the controls for the VOLTAGE 1/2 turn clockwise.

5. Have a dc shunt available to connect across the output terminals on the front panel. Ensure that the rating of the dc shunt and the wire exceed the output current capability of the power supply.

6. Connect a digital voltmeter (DVM) across the dc shunt, observing the correct polarity. The combined accuracy of the DVM and dc shunt must be better than 0.1%.

7. Turn the front panel POWER switch to the ON position (switch button in).

8. Turn each of the controls for the CURRENT slowly clockwise and observe the values of the CURRENT display and the DVM. Adjust the controls for the CURRENT across their full ranges.

9. Compare the DVM reading with each of the front panel display readings to verify the accuracy of the front panel displays for CURRENT. The DVM reading must be converted to current by multiplying the DVM reading by a conversion factor equal to the dc current rating of the shunt divided by the burden voltage rating of the shunt.

10. Ensure that the controls for CURRENT adjust the output currents across the full rated current range. Also, the CC indicator should be illuminated and the CV and OVERLOAD indicators should be off.

3.5.4 Fixed 5V Operation Check

1. Ensure that the front panel POWER switch is in the OFF position (switch button out).

2. Connect a digital voltmeter (DVM) across the 5V output on the front panel, observing the correct polarity. The DVM accuracy should be better than 0.1%.

3. Turn the front panel POWER switch to the ON position (switch button in).

4. Ensure that the output voltage is 5V, ±0.25V and the OVERLOAD indicator is off.

5. Turn the front panel POWER switch to the OFF position (switch button out).

6. Connect a 1.67Ω load across the 5V output terminals on the front panel. Ensure that the load could dissipate 15 watt and that the wiring could carry 3A.

7. Turn the front panel POWER switch to the ON position (switch button in).

8. Ensure that the output voltage remains at 5V, ±0.25V and that the OVERLOAD indicator is off.

9. Turn the front panel POWER switch to the OFF position (switch button out).

10. Connect a shorting jumper across the 5V output terminals on the front panel. Ensure that the jumper could carry 3A.

11. Turn the front panel POWER switch to the ON position (switch button in).

12. Ensure that the OVERLOAD indicator is on.

3.6 OPERATION SET-UP

The two adjustable outputs of the power supply are capable of operating in constant-voltage or constant-current mode. The mode of operation is dependent on the settings of the VOLTAGE and CURRENT controls and resistance of the load. The power supply could automatically crossover between the two modes of operation in response to load demands. The mode of operation is indicated with front panel LED's: CV for constant-voltage and CC for constant-current. Refer to Figure 3-3.

The fixed 5V output operates in the constant-voltage mode. Overload protection is provided with a fixed current limit of 3A. The current limit has a foldback characteristic wherein the output current is reduced linearly from 3A as the load causes the output voltage to drop below 5V. Under short-circuit conditions, the output current would be 0.5A.

3.6.1 Constant-Voltage Mode of Operation

The adjustable outputs of the power supply will operate in constant-voltage mode whenever the load current is less than the current setting. (Note that the load current is equal to the output voltage divided by the load resistance.) In this mode, the power supply maintains the output voltage precisely regulated to the voltage setting while the load current varies with the load

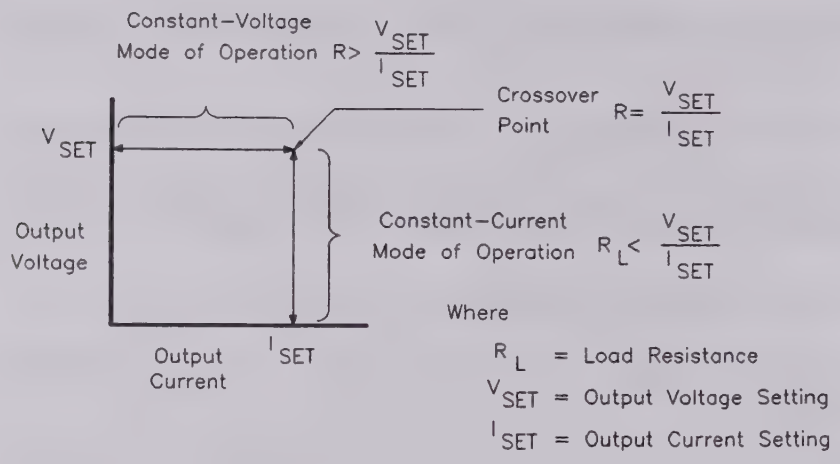

Figure 3-3. CV and CC Mode of Operation

requirements. This condition would be maintained as long as the load current is less than the current setting. If the load resistance decreases to where the load current attempts to exceed the current setting, the output current would be regulated at the set value and the output voltage would then decrease. This is the automatic crossover to constant-current mode of operation.

3.6.2 Constant-Current Mode of Operation

The adjustable outputs of the power supply will operate in constant-current mode whenever the load resistance times the current limit setting is less than the voltage setting. In this mode, the power supply maintains the output current precisely regulated to the current setting while the load voltage varies with load requirements. This condition would be maintained as long as the load resistance is less than the voltage setting divided by the current setting. If the load resistance increases to where the load voltage attempts to exceed the voltage setting, the output voltage would be regulated to the set value and the output current would then decrease. This is the automatic crossover to constant-voltage mode of operation.

3.6.3 Adjustment of Constant-Voltage Operation

Use the following procedure to set the adjustable outputs of the power supply for constant-voltage mode of operation:

1. Turn the front panel POWER switch to the ON position.

2. Adjust the VOLTAGE controls to the desired voltage setting. The CV indicator should be illuminated.

3. Turn the front panel POWER switch to the OFF position.

4. Turn the front panel CURRENT controls to fully counter-clockwise.

5. Short the positive and negative output terminals. Ensure that the jumper could safely conduct the maximum output current of the power supply.

6. Turn the front panel POWER switch to the ON position.

7. Adjust the CURRENT controls to the desired current limit value as would be determined by the load. The CC indicator should be illuminated.

   The current limit must be greater than the maximum peak current required by the load. If the load current attempts to exceed the limit value, the power supply will enter the constant-current mode of operation: The output voltage will decrease and will no longer be regulated.

8. Turn the front panel POWER switch to the OFF position. Remove the shorting jumper from the output terminals, and connect the load.

9. Turn the front panel POWER switch to the ON position.

3.6.4 Adjustment of Constant-Current Operation

Use the following procedure to set the adjustable outputs of the power supply for constant-current mode of operation:

1. Turn the front panel POWER switch to the ON position.

2. Adjust the VOLTAGE controls to the desired voltage limit value as determined by the load. The CV indicator should be illuminated.

   The voltage limit must be greater than the maximum voltage drop required by the load while conducting the desired output current. If the load voltage attempts to exceed the limit value (resulting from a load resistance increase), the power supply will enter the constant-voltage mode of operation: The output current will decrease and will no longer be regulated.

3. Turn the front panel POWER switch to the OFF position.

4. Turn the front panel CURRENT controls to fully counter-clockwise.

5. Short the positive and negative output terminals. Ensure that the jumper could safely conduct the maximum output current of the power supply.

6. Turn the front panel POWER switch to the ON position.

7. Adjust the CURRENT controls to the desired current setting. The CC indicator should be illuminated.

8. Turn the front panel POWER switch to the OFF position. Remove the shorting jumper from the output terminals, and connect the load.

9. Turn the front panel POWER switch to the ON position.

3.6.5 Independent Operation

The two adjustable outputs and the 5V fixed output are isolated from each other, and could be used individually to power circuits that do not have a common ground reference. All three of the outputs could be utilized in a variety of configurations: with their output terminals floating; with either the positive or negative terminal connected to chassis ground; with a dual-polarity output where the positive terminal of one output is grounded and the negative terminal of the other (such as 0 to ±30V for the LT 30-3); with the outputs in series to increase the total output voltage (such as 65V for the LT 30-3 with all three outputs connected in series). In any of the configurations, the independent controls of the master and slave sections allow their outputs to be set to different voltage and current levels, without interaction.

CAUTION

Limit the float voltage of an output from chassis to 300VPK. Limit the voltage difference between output terminals to 100VPK.

Refer to Figure 3-4, and use the following procedure to set the power supply for independent mode of operation:

1. Ensure that the POWER switch is in the OFF position.

2. Disengage (out) both of the TRACKING switches.

3. Interconnect the outputs to the desired configuration.

4. Turn the POWER switch to the ON position, and adjust the VOLTAGE and CURRENT controls to the desired output values.

5. Turn the POWER switch to the OFF position.

6. Connect the outputs to the load.

7. Turn the POWER switch to the ON position.

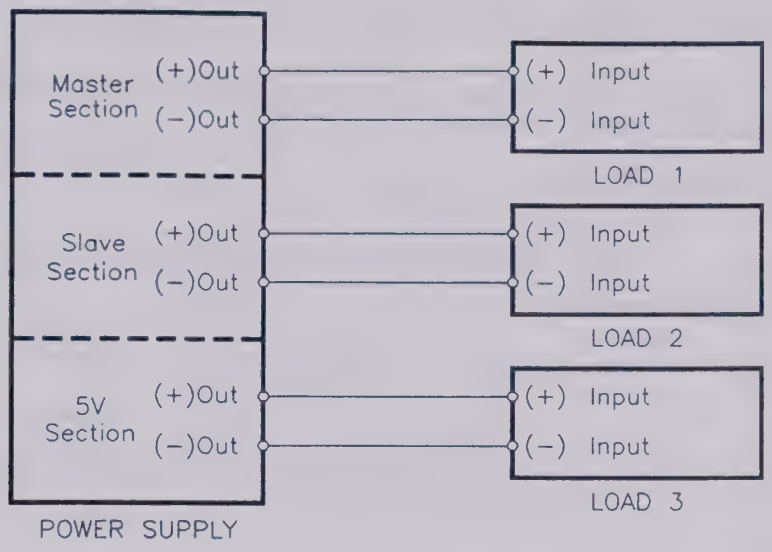

Figure 3-4. Independent Operation

3.6.6 Series-Tracking Operation

In the series-tracking mode of operation, the two adjustable outputs are automatically connected in a master/slave configuration. Also, the NEGATIVE terminal of the master section is internally connected to the POSITIVE terminal of the slave section. Both outputs are controlled simultaneously by the VOLTAGE and CURRENT controls of the master section; the output voltage and current of the slave section will equal that of the master section. The series-connected outputs could be utilized as a single output at twice the voltage rating (such as 0 to 60V for the LT 30-3), or as dual-polarity outputs (such as 0 to ±30V for the LT 30-3). The output current capability is equal to that of a single section.

When configured as dual-polarity outputs, the output current setting could be adjusted independently for both the master and slave sections. When the current setting of the slave section is exceeded, its output will enter the constant-current mode of operation; the master section will remain in the constant-voltage mode of operation. However, exceeding the current setting of the master section (resulting in constant-current operation) will also affect the output voltage of the slave: The slave section output voltage will follow the variations of the master section voltage since the master section sets the output of the slave. If this interaction is undesired, the independent mode of operation should be utilized.

The displays of the master and slave sections could be used to simultaneously indicate the output voltage and current. The MASTER DISPLAY SELECTOR switch should be set to display the output voltage, and the SLAVE DISPLAY SELECTOR switch should be set for the output

current. If the outputs are configured for a single series-connected output, the displayed value for the output voltage must be doubled because only the output of the master section is indicated.

Refer to Figure 3-5 or Figure 3-6, and use the following procedure to configure the power supplies for the series-tracking mode of operation:

1. Ensure that the POWER switch is in the OFF position.

2. Disengage (out) the right TRACKING switch and engage (in) the left TRACKING switch.

3. Adjust the VOLTAGE and CURRENT controls of the slave section to fully clockwise.

4. Set the MASTER DISPLAY SELECTOR switch to indicate voltage (VOLTS position), and the SLAVE DISPLAY SELECTOR switch to indicate current (AMPS position).

5. Turn the POWER switch to the ON position.

6. Adjust the VOLTAGE and CURRENT controls to the desired output values.

7. Turn the POWER switch to the OFF position.

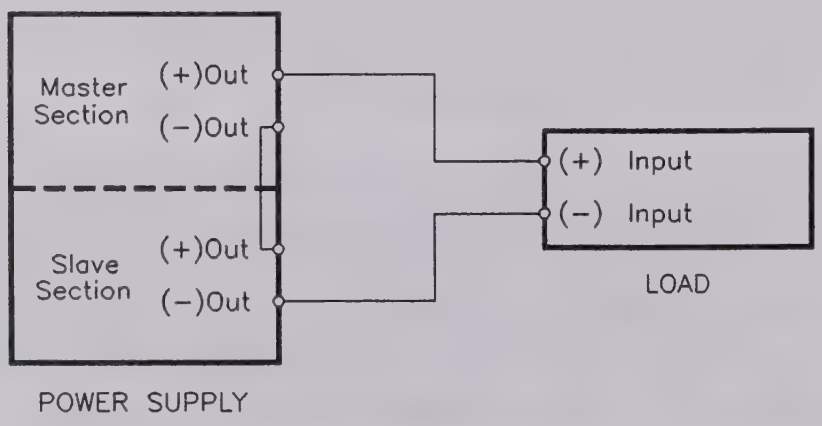

Figure 3-5. Series-Tracking Operation — Single Output

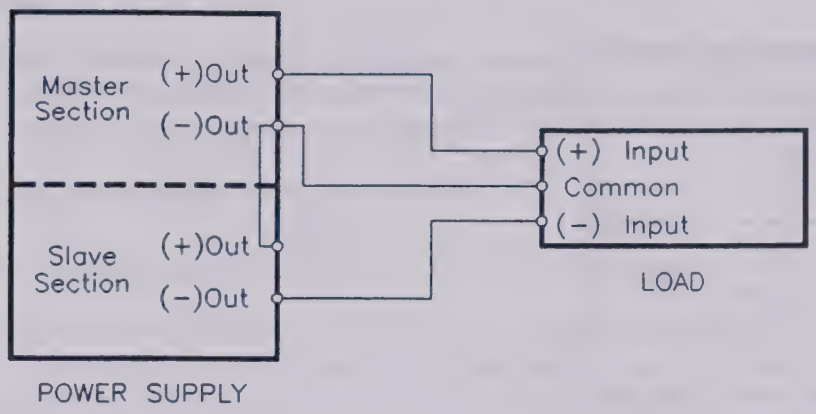

Figure 3-6. Series-Tracking Operation — Dual-Polarity Outputs

8. Connect the outputs to the load.

9. Turn the POWER switch to the ON position.

3.6.7 Parallel-Tracking Operation

In the parallel-tracking mode of operation, the two adjustable outputs are automatically connected in a master/slave configuration. Also, both the NEGATIVE and POSITIVE terminals of the master and slave sections are connected internally. Both outputs are controlled simultaneously by the VOLTAGE and CURRENT controls of the master section; the output voltage and current of the slave section will equal that of the master section. The parallel-connected outputs are utilized as a single output, at twice the current rating (such as 0 to 10A for the LT 18-5).

The displays of the master and slave sections could be used to simultaneously indicate the output voltage and current. The MASTER DISPLAY SELECTOR switch should be set to display the output voltage, and the SLAVE DISPLAY SELECTOR switch should be set for the output current. The displayed value for the output current must be doubled because only the output of the slave section is indicated.

Refer to Figure 3-7, and use the following procedure to configure the power supplies for the parallel-tracking mode of operation:

1. Ensure that the POWER switch is in the OFF position.

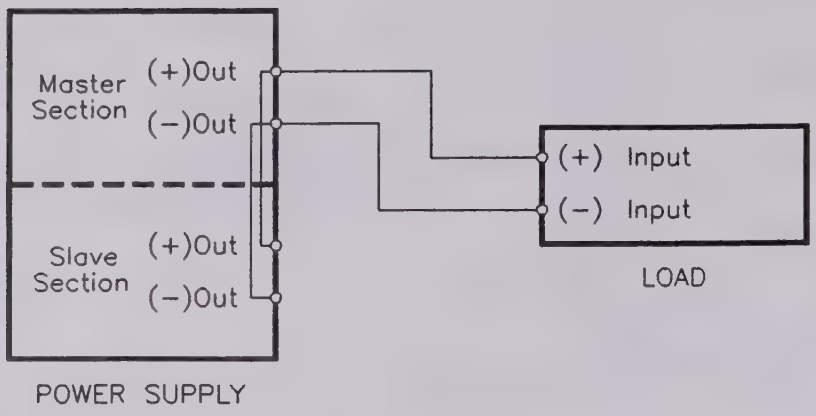

Figure 3-7. Parallel-Tracking Operation

2. Engage (in) the right and left TRACKING switches.

3. Adjust the VOLTAGE and CURRENT controls of the slave section to fully clockwise.

4. Set the MASTER DISPLAY SELECTOR switch to indicate voltage (VOLTS position), and the SLAVE DISPLAY SELECTOR switch to indicate current (AMPS position).

5. Turn the POWER switch to the ON position.

6. Adjust the VOLTAGE and CURRENT controls to the desired output values.

7. Turn the POWER switch to the OFF position.

8. Connect the load to the output terminals of the master section.

9. Turn the POWER switch to the ON position.

3.7 REVERSE POLARITY PROTECTION

The outputs of the power supply are protected against reverse polarity sources connected to the output terminals. The output terminals have diodes connected directly across them such that

they are normally reversed-biased. If the voltage at an output were to reverse in polarity, the diode would conduct and clamp it to its forward voltage drop.

CAUTION

Connecting a voltage source of reversed polarity to the output terminals could result in damage to the unit if the resulting current exceeds the current capabilities of the reverse polarity protection diode.

3.8 BATTERY CHARGING

When using a power supply to charge a battery, the following precautions should be taken:

1. Connect an isolation diode in series with one of the output terminals of the power supply. This diode will prevent discharge of the battery if the power supply were to be turned off. The diode must have suitable current and voltage ratings and should be mounted on an appropriate heat sink.

2. Adjust the VOLTAGE setting to the desired float voltage with the power supply disconnected from the battery. The VOLTAGE setting should compensate for the voltage drop of the isolation diode.

3. Adjust the CURRENT setting to the desired current limit value when charging a battery.

   When recharging a battery, the power supply will initially operate in constant-current mode, regulating the output current to the current limit value. As the battery charges the battery voltage would increase until the float voltage setting is reached.

   The power supply would then enter the constant-voltage mode of operation, regulating the output voltage at the float voltage setting. The battery current would then decrease from the current limit setting and eventually drop to a low float current level when the battery is fully charged.

SECTION 4
MAINTENANCE

WARNING

Servicing should be performed only by qualified personnel. Operator personnel should not remove the enclosure top cover. Follow the safety precautions listed in Section SAFETY NOTICE at the beginning of this manual.

4.1 GENERAL SERVICING

If the power supply appears to be operating improperly, determine whether the power supply or the load is the cause by performing the tests presented in Subsection 3.5, INITIAL FUNCTIONAL TESTS.

If the power supply fails to operate, and the front panel displays (VOLTAGE and CURRENT) and indicators (CV or CC) are not illuminated, perform the basic tests of Subsections 4.1.1 through 4.1.3.

4.1.1 AC LINE SELECT Switch Settings

Ensure that the rear panel AC LINE SELECT switches are set for the available AC power source voltage. Refer to Subsection 2.6, AC LINE VOLTAGE SELECTION, for instructions on how to change the switch settings.

4.1.2 AC Line Cord Test

Determine the condition of the AC power cord by measuring with an ohmmeter the resistance of the connections between the plug and connector. Ensure that continuity exists between corresponding supply and ground terminals of the plug and connector. Replace a cord that measures a high resistance or open circuit, or that has a damaged cable, plug, or connector.

4.1.3 AC Line Fuse Test

Ensure that the AC input fuse has the proper rating. Refer to Subsection 2.7, AC LINE FUSE, for instructions on how to remove the AC input fuse. If the fuse rating is correct, determine whether the fuse is open by measuring with an ohmmeter the resistance of the fuse. Replace an open fuse only with one of the proper rating. If the fuse is replaced and opens again, there is a problem internal to the unit that would require servicing by a qualified personnel.

4.1.4 Cleaning

The exterior of the unit should be cleaned with a mild solution of detergent and water. The solution should be applied onto a soft cloth, and not directly to the surface of the unit. To prevent damage to materials, do not use aromatic hydrocarbons or chlorinated solvents for cleaning.

4.2 CALIBRATION

WARNING

The calibration procedures are performed with the power supply top cover removed and the power on. Adjustment potentiometers are located in circuits that are connected to potentially lethal voltages. Use insulated tools when making adjustments to circuit potentiometers, and do not touch any components or circuits. To prevent personal injury, following the safety precautions listed in Section SAFETY NOTICE in the beginning of this manual.

The power supply has been fully calibrated prior to shipment. Typically, readjustment is not necessary unless components or circuit board assemblies have been replaced. If readjustment is to be performed, the accuracy of the voltmeter used for voltage measurements and the combined accuracy of the voltmeter and dc shunt used for current measurements must be better than 0.1%. Refer to Figures 4-1, 4-2, 4-3, and 4-4 for the location of the adjustment potentiometers.

4.3 INDEPENDENT OPERATION CALIBRATION

To perform calibration of the independent mode of operation, ensure that both of the TRACKING switches are disengaged (out). The procedures are to be performed for both the master and slave sections.

4.3.1 Output Voltage Zero Adjustment

Use the following procedure to adjust the output voltage minimum value:

1. Connect external voltmeters across the output terminals of the power supply.

2. Set the VOLTAGE controls to their minimum settings (fully counter-clockwise).

3. Adjust potentiometers VR102 (master section) and VR302 (slave section) on the Main Control Board for a reading of -15mV, ±15mV on the external voltmeter at each section output.

4.3.2 Output Voltage Range Adjustment

Use the following procedure to adjust the output voltage maximum value:

1. Connect external voltmeters across the output terminals of the power supply.

2. Set the VOLTAGE controls to their maximum settings (fully clockwise).

3. Adjust potentiometers VR101 (master section) and VR301 (slave section) on the Main Control Board for a reading on the external voltmeter at each section output of 1.05 times the rated output voltage of the unit.

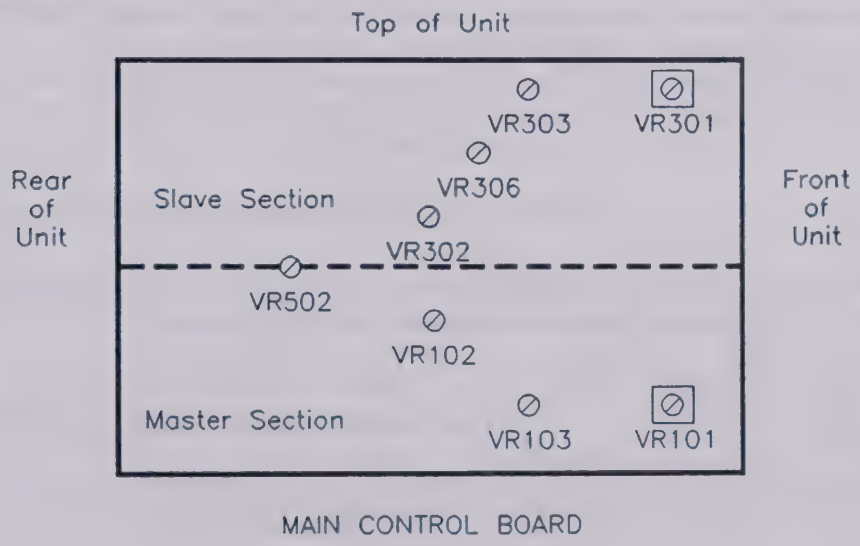

Figure 4-1. Main Control Board Potentiometer Locations

4.3.3 Voltage Display Adjustment

After performing the steps in Subsection 4.3.2, OUTPUT VOLTAGE RANGE ADJUSTMENT, use the following procedure to adjust the VOLTAGE displays:

1. Reset the VOLTAGE controls so that the external voltmeter readings at each section output are equal to the rated output voltage of the unit.

2. Set the master and slave DISPLAY SELECTOR switches to the VOLTS positions.

3. Adjust potentiometers VR201 (master section) and VR601 (slave section) on the Display Board so that the unit's VOLTAGE display for each section has a reading equal to the rated output voltage of the unit.

4.3.4 Output Current Range Adjustment

Use the following procedure to adjust the output current maximum value:

1. Set the VOLTAGE controls of each section to 1/2 turn clockwise.

2. With the power supply turned off, connect an external dc shunt across the output terminals of the power supply. Ensure that the current rating of the dc shunt and wiring exceed 1.05 times the rated output current of the unit.

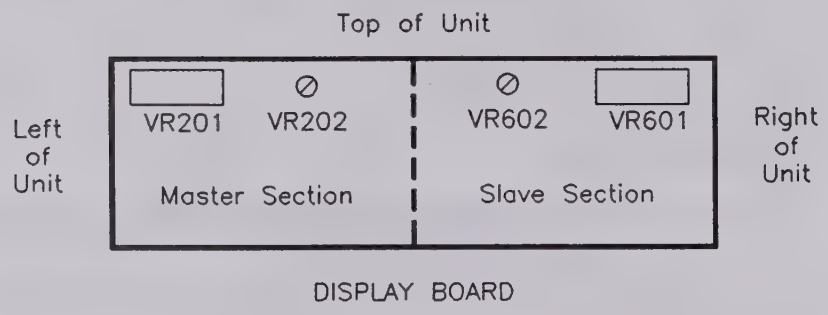

Figure 4-2. Display Board Potentiometer Locations

3. Set the CURRENT controls of each section to their maximum settings (fully clockwise).

4. Adjust potentiometers VR103 (master section) and VR303 (slave section) on the Main Control Board while monitoring the reading on the external voltmeter of each section. Calculate the output current by multiplying the voltage reading by a conversion factor equal to the rated current of the dc shunt divided by the rated burden voltage of the dc shunt. Adjust for an output current of each section equal to 1.05 times the rated output current of the unit.

4.3.5 Current Display Adjustment

After performing the steps in Subsection 4.3.4, OUTPUT CURRENT RANGE ADJUSTMENT, use the following procedure to adjust the CURRENT displays:

1. Reset the CURRENT controls of each section while monitoring the reading on the external voltmeter. Calculate the output current by multiplying the voltage reading by a conversion factor equal to the rated current of the dc shunt divided by the rated burden voltage of the dc shunt. Reset the controls for an output current of each section equal to the rated output current of the unit.

2. Set the master and slave DISPLAY SELECTOR switches to the AMPS positions.

3. Adjust potentiometers VR202 (master section) and VR602 (slave section) on the Display Board so that the unit's CURRENT display for each section has a reading equal to the rated output current of the unit.

4.4 SERIES-TRACKING OPERATION CALIBRATION

To perform calibration of the series-tracking mode of operation, ensure that the left TRACKING switch is engaged (in) and that the right TRACKING switch is disengaged (out).

4.4.1 Slave Voltage-Zero Tracking Adjustment

Use the following procedure to adjust the output voltage minimum value of the slave section while in the series-tracking mode of operation:

1. Connect external voltmeters across the output terminals of the power supply.

2. Set the CURRENT control of the slave section to 1/2 turn clockwise.

3. Set the VOLTAGE control of the master section fully counter-clockwise.

4. Adjust potentiometer VR306 (slave section) on the Main Control Board so that the readings on the external voltmeters are equal at each section output.

4.4.2 Slave Voltage-Range Tracking Adjustment

Use the following procedure to adjust the output voltage maximum value of the slave section while in the series-tracking mode of operation:

1. Connect external voltmeters across the output terminals of the power supply.

2. Set the CURRENT control of the slave section to 1/2 turn clockwise.

3. Set the VOLTAGE control of the master section fully clockwise.

4. Adjust potentiometer VR501 on the Interface Board so that the readings on the external voltmeters are equal at each section output.

4.5 PARALLEL-TRACKING CURRENT RANGE ADJUSTMENT

Use the following procedure to adjust the output current maximum value of the unit while in the parallel-tracking mode of operation:

1. Disengage (out) both of the TRACKING switches to select the independent mode of operation.

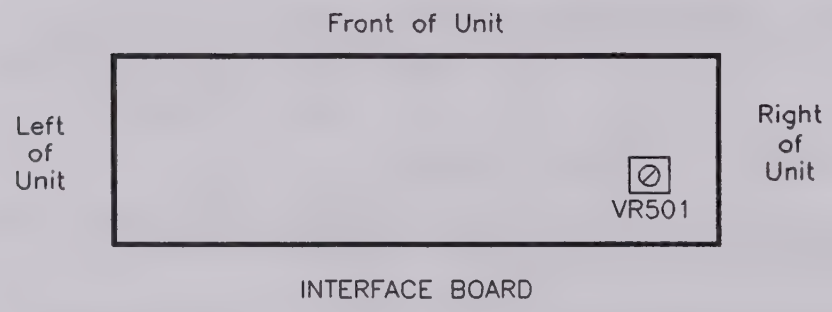

Figure 4-3. Interface Board Potentiometer Location

2. Set the VOLTAGE control of the master section to 1/2 turn clockwise.

3. With the power supply turned off, connect an external dc shunt across the output terminals of the master section. Ensure that the current rating of the dc shunt and wiring exceed the rated output current of the unit.

4. Turn the power supply on and set the CURRENT control of the master so that the output current of the master equals the rated current of the unit. Do not change the setting during the following steps. Calculate the output current by multiplying the voltage reading by a conversion factor equal to the rated current of the dc shunt divided by the rated burden voltage of the dc shunt.

5. With the power supply turned off, engage (in) both of the TRACKING switches to select the parallel-tracking mode of operation.

6. Set the VOLTAGE control of the slave section to 1/2 turn clockwise.

7. Set the CURRENT control of the slave section to fully clockwise.

8. Turn the power supply on and adjust potentiometer VR502 on the Main Control Board while monitoring the reading on the external voltmeter of the current shunt. Calculate the output current by multiplying the voltage reading by a conversion factor equal to the rated current of the dc shunt divided by the rated burden voltage of the dc shunt. Adjust for an output current equal to double the rated output current of the unit.

4.6 5V OUTPUT CALIBRATION

Calibration of the 5V output does not affect the calibration of the adjustable outputs.

4.6.1 5V Output Voltage Adjustment

Use the following procedure to adjust the output voltage:

1. Connect an external voltmeter across the 5V output terminals of the power supply.

2. Adjust potentiometer VR401 on the 5V Control Board for a reading on the external voltmeter of 5.00V.

4.6.2 5V Output Current Limit Adjustment

Use the following procedure to adjust the current limit:

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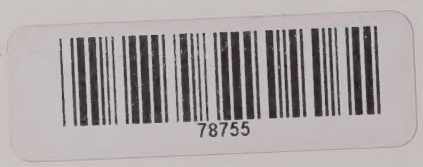

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